



Standard Solar Constant and Zero Air Mass Solar Spectral Irradiance Tables¹

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1. Scope

1.1 These tables define the solar constant and zero air mass solar spectral irradiance for use in thermal analysis, thermal balance testing, and other tests of spacecraft and spacecraft components and materials. Typical applications include the calculation of solar absorptance from spectral reflectance data and the specification of solar UV exposure of materials during simulated space radiation testing.

1.2 These tables are based upon data from experimental measurements made from high-altitude aircraft, spacecraft, and the earth's surface and from solar spectral irradiance models.

1.3 The values stated in SI units are to be regarded as standard. Other units of measurement are included for information purposes only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 349 Terminology Relating to Space Simulation²

3. Terminology

3.1 *air mass* (optical air mass) (AM), *n*—the ratio of the path length or radiation through the atmosphere (l_m) at any given angle, *Z* degrees, to the sea level path length toward the zenith (l_z).

$$AM = l_m/l_z \cong \sec Z, \text{ for } Z \leq 62^\circ \quad (1)$$

Symbol: AM1 (air mass one), AM2 (air mass two)

3.2 *astronomical unit* (AU), *n*—a unit of length defined as the mean distance between the earth and the sun, that is, 149 597 890 ± 500 km.

3.3 *integrated irradiance*, *n*—spectral irradiance integrated

over a specific wavelength interval from λ_1 to λ_2 , measured in $W \cdot m^{-2}$, Symbol:

$$E_{\lambda_1 - \lambda_2} = \int_{\lambda_1}^{\lambda_2} E_\lambda d\lambda \quad (2)$$

3.4 *irradiance at a point on a surface* (*E*), *n*—quotient of the radiant flux incident on an element of the surface containing the point, by the area of that element, measured in $W \cdot m^{-2}$.

3.5 *irradiance, spectral* (*E*), *n*—the irradiance per unit wavelength interval at a specific wavelength, or as a function of wavelength measured in $W \cdot m^{-2} \cdot \mu m^{-1}$.

3.6 *solar constant*, *n*—the total solar irradiance at normal incidence on a surface in free space at the earth's mean distance from the sun (1 AU).

3.7 *zero air mass* (AMO), *n*—the absence of atmospheric attenuation of the solar irradiance at one astronomical unit from the sun.

3.8 Additional definitions will be found in Terminology E 349.

4. Solar Constant

4.1 The solar constant is 1366.1 $W \cdot m^{-2}$. This value is the mean of daily averages from six different satellites over the 1978 to 1998 time period, all measured with absolute cavity radiometers, as reported by Fröhlich and Lean (1)³. The standard deviation of this mean value is 425 ppm, with a 0.37 % minimum-to-maximum range (1363 to 1368 $W \cdot m^{-2}$).

4.2 Table 1 summarizes the results in different units, and Table 2 presents the total solar irradiance at various planetary distances from the sun.

5. Solar Spectral Irradiance (Zero Air Mass)

5.1 The zero air mass solar spectral irradiance is based on data from satellites, space shuttle missions, high-altitude aircraft, rocket soundings, ground-based solar telescopes, and modeled spectral irradiance.

5.2 Table 3 presents the solar spectral irradiance in tabular form for the range from 0.1195 to 1000 μm . The first column gives the wavelength (λ) in μm ; the second gives the spectral irradiance (E_λ) at λ in $W \cdot m^{-2} \cdot \mu m^{-1}$; the third gives the total irradiance for the range from 0 to λ ($E_{0-\lambda}$) in $W \cdot m^{-2}$; and the

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² *Annual Book of ASTM Standards*, Vol 15.03.

³ The boldface numbers in parentheses refer to the list of references at the end of these tables.